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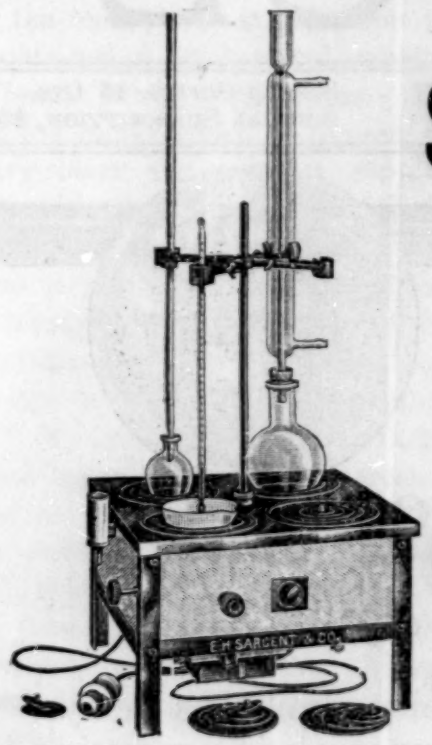

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DOCTORATES CONFERRED IN THE SCIENCES BY AMERICAN UNIVERSITIES IN 1921

THROUGH the generous cooperation of the registrars of the various American universities granting doctorates in the sciences, the Research Information Service of the National Research Council is able to offer the following compilation of doctorates granted during the collegiate year 1920-1921. Through this same cooperation statistics are now available for the period 1916-1919. The information for these three years has not been compiled heretofore and therefore was lacking in the tables as published last year (SCIENCE, 52, 478, 514). These figures are of value as an indication of the academic activity during the World War. As would be expected, the number of doctorates fell off as the size of the American army increased (1917, 372; 1918, 293; 1919, 180). This is a confirmation of the acknowledged fact that the scientific men of the country played an increasingly important part in the activities of the army and navy.

In 1921 there were 332 doctorates conferred in the natural sciences by 32 institutions, as compared with 323 by the same number of institutions in 1920. (The figures reported in 1920 by institutions and by subjects have been corrected in certain cases from later information). It is interesting that the figures for 1917 should be so much higher than those for any other year reported in the tables. How long will it be before those figures are again reached?

Marked changes in the order of institutions are in the shift of Minnesota from nineteenth place in 1920 to tenth place in 1921, and of George Washington from tenth place in 1920 to twenty-sixth place in 1921. Comparisons of this kind are of uncertain significance because the number of degrees granted by an institution during any collegiate year depends upon many factors.

DOCTORATES CONFERRED IN THE SCIENCES BY AMERICAN UNIVERSITIES

	'12	'13	'14	'15	'16	'17	'18	'19	'20	'21
Chicago	37	16	28	53	53	39	55	23	43	42
Cornell	28	30	36	26	24	38	30	21	35	33
Columbia	36	27	21	27	34	37	24	11	24	27
Yale	21	19	13	20	24	25	9	4	23	27
Harvard	15	22	28	33	16	39	15	14	28	25
California	12	9	11	16	17	23	16	16	14	22
Johns Hopkins	23	21	18	23	22	24	7	7	21	21
Illinois	15	11	18	17	26	24	23	15	22	19
Wisconsin	14	5	17	8	22	17	16	9	24	15
Minnesota	2	2	3	4	7	9	10	8	4	16
Ohio State	5	0	0	1	2	8	7	3	6	8
Princeton	7	7	7	4	19	5	8	3	10	8
Iowa	3	2	2	2	2	3	9	4	5	7
Mass. Inst. Tech.	6	1	2	2	3	4	4	1	8	7
Michigan	8	10	5	15	10	13	8	4	9	7
Clark	6	13	7	10	9	12	4	5	4	6
Pennsylvania	9	9	5	11	16	7	10	8	5	5
Stanford	3	5	2	2	0	4	0	2	4	5
Brown	4	1	4	5	2	3	9	2	2	4
Nebraska	0	2	1	3	0	2	1	2	0	4
New York	2	3	1	3	0	6	0	2	2	4
Radcliffe	0	0	0	0	0	1	0	1	1	3
Washingt'n Univ.	1	3	1	5	0	2	2	1	3	3
Bryn Mawr	3	0	2	0	3	2	1	1	1	2
Cincinnati	1	2	2	0	2	1	1	1	2	2
Geo. Washington	2	1	2	4	5	8	3	3	9	2
N. Carolina	0	0	1	2	2	0	1	1	0	2
Pittsburgh	1	5	0	4	0	5	1	2	2	2
Catholic	1	0	0	2	1	2	4	0	1	1
Indiana	4	1	2	4	3	2	4	1	5	1
Kansas	0	0	0	0	0	0	0	0	1	1
Syracuse	0	0	0	0	0	0	4	0	2	1
Missouri	0	1	1	1	3	2	3	0	2	0
Northwestern	0	0	0	1	3	3	2	0	0	0
Notre Dame	-	-	-	-	-	0	1	0	0	0
Washington	-	-	-	-	-	0	1	0	0	0
Virginia	2	2	1	0	2	1	0	0	1	0
Boston	1	2	0	0	0	1	0	0	0	0
Totals	273	234	241	309	332	372	293	180	323	332

DOCTORATES DISTRIBUTED ACCORDING TO SCIENCES

	'12	'13	'14	'15	'16	'17	'18	'19	'20	'21
Chemistry	78	68	71	85	115	108	75	54	96	134
Zoology	20	26	25	32	33	30	35	24	38	36
Botany	30	28	34	40	36	37	39	23	48	29
Physics	30	22	23	31	35	32	17	18	19	28
Psychology	29	24	12	22	19	32	30	21	38	26
Bacteriology	6	3	6	4	4	11	11	6	7	19
Mathematics	22	21	25	23	34	30	23	7	19	16
Geology	23	14	13	26	17	24	14	5	17	11
Physiology	12	2	8	8	14	18	11	1	13	8
Astronomy	2	11	2	7	6	5	0	1	4	5
Geography	0	1	0	3	3	3	1	0	3	5
Anatomy	6	1	2	5	1	3	5	0	3	4
Anthropology	0	3	2	6	1	4	2	0	2	4
Agriculture	11	8	9	9	6	19	18	12	8	3
Metallurgy	0	0	0	1	1	0	1	1	0	2
Engineering	2	0	4	2	2	5	4	1	5	1
Pathology	2	2	1	2	2	6	8	6	3	1
Mineralogy	0	0	0	1	0	0	0	0	0	0
Meteorology	0	0	0	0	0	1	1	0	0	0
Paleontology	0	0	4	2	3	4	0	0	0	0
Totals	273	234	241	309	332	372	293	180	323	332

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YALE: George McCutcheon McBride, ''Land tenure in Latin America.'' Stanislaus Thomas Novakovsky, ''Climate and weather of the Russian Far East.''

Geology

BRYN MAWR: Helen Morningstar, ''Fauna of the Pottsville formation of Ohio below the Mercer limestones.''

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CHICAGO: George Charlton Matson, ''Phosphate deposits of Florida.''

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JOHNS HOPKINS: Edmund Maute Spieker, "Molluscan fauna of the Zorritos formation of northern Peru."
NEBRASKA: Jerome Benjamin Burnett, "Geological study of northeastern Coahuila, Mexico."
OHIO STATE: Guy Woolard Conrey, "Geology of Wayne County, Ohio."
WISCONSIN: William Oscar Blanchard, "Geonomic interpretation of the cuesta of southwestern Wisconsin." Clifton Sherwin Corbett, "Some hydrous aluminium silicates as schist-making minerals."
YALE: Malcolm Havens Bissell, "Triassic area of the new Cumberland Quadrangle, Pennsylvania."

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CHICAGO: Mayme Irwin Logsdon, "Equivalence and reduction of pairs of hermitian forms." Irwin Roman, "Transformation of waves through a symmetrical optical instrument." William L. G. Williams, "Fundamental systems of formal modular seminvariants of the binary cubic." Frank Edwin Wood, "Certain relations between the projective theory of surfaces and the projective theory of congruences."
COLUMBIA: Jesse Douglas, "Certain two-point properties of general families of curves: the geometry of variations."
ILLINOIS: Beulah May Armstrong, "Mathematical induction in group theory." William Edmund Edington, "Abstract group definitions and applications."
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JOHNS HOPKINS: Flora Dobler Sutton, "Certain chains of theorems in reflective geometry."
PRINCETON: Philip Franklin, "Four color problem."
RADCLIFFE: Rachel Blodgett, "Determination of the coefficient in interpolation formulæ and a study of the approximate solution of integral equations."
SYRACUSE: Jung Sun, "Some determinant theorems."
YALE: Malcolm Cecil Foster, "Rectilinear congruences referred to special surfaces."

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GEORGE WASHINGTON: Raymond W. Woodward, "Manufacture and properties of steel plates containing zirconium and other elements."

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MINNESOTA: Charles Edward Nixon, "Substance concerned in the colloidal gold test and the nature of the reaction."

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CHICAGO: Ira Garnett Barber, "Secondary electron emission from copper surfaces." Otto Koppius, "Comparison of thermionic and photoelectric work-functions in platinum." Loualien Frederick Miller, "Pressure shifts in a calcium arc." John Preston Minton, "Sensitivity of normal and defective ears for tones of various frequencies."
CORNELL: Jacob Roland Collins, "Influence of certain dissolved substances on the infra-red absorption of water." Guy Everett Grantham, "Study of some infra-red absorption spectra." Lewis Richard Koller, "Factors influencing the resistance of sputtered platinum films."
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COLUMBIA: Albert Baird Hastings, ''Physiology of fatigue; physico-chemical manifestations of fatigue in blood.'' Ethel W. Wickwire, ''Reciprocal reaction in the cardio-vascular system.''

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MINNESOTA: Chester Arthur Stewart, ''Vital capacity of lungs of children in health and disease.''

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CALIFORNIA: Dorothy M. H. Yates, ''Study of some high school seniors of exceptional intelligence.''

CHICAGO: Forrest Alva Kingsbury, ''Group intelligence scale for primary grades.'' Helen Lois Koch, ''Influence of mechanical guidance upon maze learning.'' Katherine Eva Ludgate, ''Effect of manual guidance upon maze learning.'' Margaret Wooster, ''Certain factors in the formation of new spatial co-ordination.''

CLARK: Carroll Cornelius Pratt, ''Qualitative aspects of bitonal complexes.'' Matsusaburo Yokoyama, ''Affective tendency as conditioned by color and form.''

COLUMBIA: Florence Edith Carothers, ''Psychological examinations for college freshmen.'' Margaret Evertson Cobb, ''Adenoids and diseased tonsils; their effect upon general intelligence.'' Herbert Wesley Rogers, ''Some empirical tests in vocational selection.''

CORNELL: Anna Kellman Whitchurch, ''Illusory perception of movement on the skin.''

HARVARD: Harrison LeRoy Harley, ''Development of psychological tests for office clerks.'' Joseph Paul Hettwer, ''Studies on the conditioned reflex.'' William Moulton Marston, ''Systolic blood pressure and reaction-time symptoms of deception and of constituent mental states.''

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JOHNS HOPKINS: Curt Paul Richter, ''Behavior of the rat.''

MINNESOTA: Raymond Otto Filter, ''Character traits.'' Oscar Julius Johnson, ''St. Paul non-verbal intelligence examination for primary pupils.'' Calvin Perry Stone, ''Analysis of the congenital sexual behavior of the male albino rat.''

PENNSYLVANIA: Karl Greenwood Miller, ''Diagnostic study of fifty college students.'' Morris Simon Viteles, ''Job specifications and diagnostic tests of job competency designed for auditing division of street railway company.''

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CORNELL: Hazel Elisabeth Branch, "Internal anatomy of *Trichoptera.*" John D. Detwiler, "Biology of three little known clover insects." Dean L. Gamble, "Morphology of ribs and transverse processes in *Necturus maculatus.*" Harry Hazelton Knight, "Insects affecting the fruit of the apple with particular reference to the characteristics of the resulting scars." Rowland Willis Leiby, "Polyembryonic development of *Copidosoma gelechiæ* with notes on its biology." Mortimer Demarest Leonard, "Revision of the dipterous family *Rhagionidæ* (leptidæ) in the United States and Canada." John Thomas Lloyd, "Biology of North American caddis worms." Helen Elizabeth Murphy, "Metamorphosis of may-fly (*Ephemerine*) mouth-parts."

HARVARD: Samuel Wood Chase, "Mesonephros and urogenital ducts of *Necturus maculosus rafinesque.*" William Harder Cole, "Transplantation of skin in frog tadpoles." Emmett Reid Dunn, "Salamanders of the family *Plethodontidæ.*" Cleveland Sylvester Simkins, "Origin and migration of so-called primordial germ cells in the mouse and rat." George Carlos Wheeler, "Larvæ of subfamilies *Dolichoderinæ* and *Formicinæ;* developmental stages of ants."

ILLINOIS: Florence Sander Hague, "Studies on *Sparganophilus Eiseni Smith.*" Ada Roberta Hall, "Effects of oxygen and carbon dioxide on the development of certain cold blooded vertebrates." Ezra Clarence Harrah, "North American Monostomes." Lewis Bradford Ripley, "Morphology and postembryology of *Noctuid* larvæ." Fenner Satterthwaite Stickney," "Head capsule of *Coleoptera.*"

JOHNS HOPKINS: John Graham Edwards, "Effect of chemicals on locomotion in amœba." Alphonse M. Schwitalla, "Influence of temperature on the rate of locomotion in amœba."

MICHIGAN: Horace Burrington Baker, "Distribution of mussels in Douglas Lake."

MINNESOTA: George Henshaw Childs, "Digestive system of diplopods with special reference to parajulus." Samuel Alexander Graham, "Influence of physical factors of the environment on the ecology of certain insects in logs."

OHIO STATE: Carl John Drake, "Ecological and life-history studies of *Heteroptera.*"

PRINCETON: Orren Williams Hyman, "Dimorphism of the spermatozoa of *Fasciolaria Tulipa.*"

RADCLIFFE: Esther Wadsworth Hall, "Braconids parasitic on aphids and their life history."

STANFORD: K. Kunhi Kannan, "Function of the prothoracic plate in *Mylabrid* (Bruchid) larvæ."

WISCONSIN: Sarah Van Hoosen Jones "Inheritance in pigeons; checks and bars and other modifications of black."

YALE: John Spangler Nicholas, "Regulation of posture in the forelimb of *Amblystoma punctatum.*" Leon Stansfield Stone, "Development of the cranial ganglia and the lateral line sense organs in *Amblystoma punctatum.*"

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THE ORGANIZATION OF KNOWLEDGE

II

The aim of all organized knowledge is to increase the certainty of prediction, or as a practical question the science of forecasting, the urgency of which was never more apparent than it is to-day. As has been said by Jevons, "With the progress of any branch of science the element of chance becomes much reduced," for "Not only are laws discovered which enable results to be predicted . . . but the systematic examination of phenomena and substances leads to important and novel discoveries which can in no sense be said to be accidental." The application of this principle to the science of human relations is obvious, yet rarely recognized with the required degree of clearness. A vast amount of human activity continues to be carried on, crude as it may be, in disregard of past experience but of necessity as an adventure or speculation, the evil results of which are most likely to fall upon others than those directly concerned. It is not only

true that "hopeless causes do not always fail" (in the temporary human sense), but that wrongful causes or courses may prove profitable—for a time—and to those directly concerned. It requires to be clearly kept in mind in considering civilization as a science of human relations that in this respect the interests of the individual and society may be diametrically opposed to each other. But just as the police powers control criminal propensities, so the powers of organized knowledge and of demonstrated experience hold in check the reckless intellectual speculations of the audacious but uninformed. In its final analysis the only cure of a fallacy is a demonstrated fact so clearly stated and properly applied that the truth must prevail and prove triumphant.

This conclusion is summed up by President David Starr Jordan in the remark that "The final test of truth is its livableness, the degree to which we trust our lives to it." However much falsehood may prevail and prove an individual advantage—for a time—in the long run it is only "by means of experience, personal and collective, that the human race maintains itself on earth." Such experience, also in the words of Jordan, "concerns itself chiefly with the relations of objects rather than with their ultimate constitution or their intimate nature," for "it gives the truth actually needed in actual life and it furnishes the means for the acquisition of more complete conceptions whenever in the intricacies of life such better knowledge is needed."

The principle here laid down is fundamental to a science of human relations. When the demand arises for practical knowledge, for safe guidance in affairs of business or state, the first essential need is a basis of agreed upon facts, only too often wanting in the case of those who essay upon leadership in the troubled waters of political, economic, or social controversy.

It is likewise with every question, great or small, upon which mankind stands in need of better knowledge to eliminate the prevailing error and misapplication of human effort. Only by organizing knowledge in the manner here suggested will it be possible to secure the future against the vast amount of erroneous conclusions which now hamper progress in practically every important direction in which further progress is most essential for the good of all mankind. No elaborate philosophical treatise on the "Foundations of Knowledge" or the "Human Intellect" meets this need. If typhus is at our door or sleeping sickness no vague advice on preventive measures, however well meaning, meets our needs of the situation or the expectations of the public. No philosophical platitude, no pious phrases of politics held the Indian in his struggle to survive in competition with an unlike civilization in some respects inferior to the moral and physical standards of primitive life.

In very truth it is much easier to evolve speculative theories about knowledge than to ascertain the truth or the facts concerning even the most commonplace matters of every-day existence. Herein lies the conflict between mathematics and statistics and the menace of over-emphasis of the mathematical judgment in matters which are largely questions of facts and not of philosophical inference. Because mathematics are useful—if not indispensable—in astronomy or engineering it does not at all follow that mathematical speculations can safely be applied to problems in biology or vital and social statistics. The practical truths of every-day life are relative and not absolute, all more or less conditioned by the human judgment, totally at variance with the ascertainment of the truth of physics or chemistry. The mode of reasoning most useful in sociology or political science is essentially different from the intellectual concept of accuracy in the transmission of sound waves or the transformation of energy applied to a steam engine or a turbine. Hence I am at a loss to understand the conclusion of Jevons that "As science progresses, its power of foresight rapidly increases until the mathematician in his study seems to acquire the power of anticipating matters and predicting what will happen in stated circumstances before the eye of man has ever witnessed the event." No mathematician gave a forecast of the coming of the great influenza epidemic of 1918-19, no weather

forecast of a coming storm depends upon mathematics, no fall in prices or rise in wages needs the aid of the mathematician to prognosticate events depending largely on unforeseeable contingencies, and finally, no mathematician could have or did forecast the great war and its duration and consequential loss of life and property. But knowledge properly organized would aid enormously in developing the prophetic judgment free from bias or the influence of custom or tradition. Such organization should be the first instead of the last, the most important instead of the most neglected duty of the state. Without it the present chaos and confusion must continue, while the consequences must become more disastrous. Properly organized knowledge on the multitude of matters that concern the state and society would within a single generation do more to advance the cause of true civilization of science and human progress than any other discovery within the realms of possibility.

Nothing that I have said should be construed as opposed to original thought, to the fullest uses of the imagination, lead the conclusions where they may. Such speculations concern the individual and represent opinions which may or may not be accepted as a guide to action in the affairs of every-day life. I am concerned with judgments of a public or universal nature brought forward as a contribution to truth, based upon the ascertained and digested facts of human experience. I agree entirely with Professor Dearborn that it is wrong "to be forever putting facts into the mind while never providing time to use them in thought," and I also agree with his view that "rules for thinking are wholly unnecessary," just as I am convinced of the non-utility of a knowledge of technical grammar in the art of writing. But what belongs to the realm of the imagination is a thing apart in the life of a man who is conscious of his intellectual responsibility in matters of fact and particularly when the facts represent collective experience or conclusions drawn from assembled aggregates usually in the nature of statistical data. No man has a right or a privilege to say that he *knows* what to him is only a matter of belief. On all questions of public policy, where far-reaching consequences are involved in present-day action, it is the first duty of the statesman to make sure of his facts, to clearly differentiate facts from opinion, and to act with absolute impartiality upon the evidence. Accuracy of judgment will be conditioned largely by the state of organized knowledge and its intelligent coordination to the end in view. There is much lip service of coordination in science and government, but a woeful lack of it in practice. To the extent that knowledge is better organized such coordination will become more effective as a matter of course.

Much of what is said here is implied in learned philosophical discussions, failing, however, to emphasize the practical viewpoint as illustrated in every-day experience. Thus the really extraordinary essay on "The System of the Sciences," by the late Professor Ostwald, prepared for the inauguration of the Rice Institute, must needs aid materially the cause of a better method of systematizing knowledge, although failing in the most important particular of outlining a method of classification and arrangement by which the knowledge extant can be made more readily accessible. For illustration, the suggestion that "the ordering of facts and their relationship in each individual science is the first and most important function in its development" is explained as "a discoverer of new facts may not content himself with simply imparting these facts to the world at large, but only after having recognized and fixed them does there arise for him the new great essentially scientific duty of demonstrating the relationship borne by these new facts to the existing order of knowledge in a particular field and of thus rendering them real organic parts of the entire science in question." But this admirable principle is not elucidated as it should have been by some concrete illustration based on extended experience. For while it is perfectly true that "An ordering process of this kind in each particular science has always been the principle of all progress," this conclusion is far from being as clearly recognized as it should be.

Science, in the words of Karl Pearson,

"claims for its heritage the whole domain to which the knowledge can be legitimately applied," and this is amplified by the remark that "knowledge is essentially a description and not an explanation," it being held at the same time that the object of science is to describe in conceptual shorthand the routine of the past. Hence the importance of the fact-gathering process being made as thorough as it is required to be impartial. Pearson properly points out the limitations of Sir Francis Bacon's classification of the sciences, failing in the supreme essential of a "clear distinction between the material of knowledge and knowledge itself, between the real and the ideal, or between the phenomenal world and the unreal products of metaphysical thought."

This discussion of an adequate method of classification is most illuminating, and the different attempts that have been made "show how dangerous it is for any individual to attempt to classify the sciences even if he possesses Spencer's ability." Pearson disavows for his own system the pretense of "logical exactness." For, he remarks, "science is not a mere catalogue of facts, but is the conceptual model by which we briefly resume our experience of those facts." But it would have been to better advantage if these learned conclusions had been illustrated by a few concrete examples, for only in this wise can our actual shortcomings be brought home to us.

From Bacon and Compte to Jevons, Spencer and Pearson, the classification of the sciences has been confused with the organization of knowledge as a prerequisite for an adequate and satisfactory systematic outline of the order of the universe. Pearson's own classification into abstract, concrete, and biological sciences may possibly answer the purpose, but certainly not his amplification that these are united pair and pair "by applied mathematics and biophysics."

More has been claimed for mathematics than for any other branch of science. Granted that "It is the science of exact thought as applied to natural phenomena," it does not at all follow that it is essential or even advantageous in matters in which the approximate truth guides human actions—ever has and ever will, because of the variable conditions which govern our existence or the collective existence of all mankind. No one has essayed upon this question to better advantage than Sir William Hamilton in his discussion on "The Study of Mathematics as an Exercise of Mind." Thus, for illustration, the rather startling observation that "If we consult reason, experience, and the common testimony of ancient and modern times none of our intellectual studies tend to cultivate a smaller number of faculties in a more partial or feeble manner than mathematics." He quotes a German authority to the effect that "We shall first of all admit that mathematics only cultivate the mind on a single phasis. Their object is merely form and quantity. They thus remain, as it were, only on the surface of things without reaching essential qualities or their internal or far more important relations—namely, the feelings and the will—and consequently without determining the higher faculties of activity. So likewise on the other hand the memory and imagination remain in a great measure unemployed."

Sir William Hamilton was of the opinion that mathematics "do not cultivate the power of generalization" and what is even more important as a practical conclusion "the study of mathematics educates to no sagacity in detecting the fallacies which originate in the thought itself of the reasoner." It is of the utmost importance for the present purpose that this conclusion should be clearly grasped. It being held that the inductive process of reasoning, or from the particular to the general, is the only process by which, in the vast majority of cases, conclusions can be correctly arrived at, it must be self-evident that a process of reasoning by pure deduction can not likewise serve the same or a better purpose. Sir William Hamilton makes this point more clear in the statement that "The art of reasoning right is assuredly not taught by a process in which there is no reasoning wrong," or to use his own illustration, "we do not learn to swim in water by previous practice in a pool of quicksilver." The process of fact hunting,

fact assembling, and fact analysis is the prerequisite for fact statements, and it is fact statements alone that are entitled to the serious consideration of those whose judgment and decision affects the present or future welfare of those concerned in the results of the forecasting process.

The organization of knowledge is concerned with the interpretation of the phenomena of every-day experience and not with a theory applied to their interpretation, indifferent to the facts or the nature of the facts considered. This conclusion is admirably set forth by Sir William Hamilton in the words that "Mathematics often afford us no assistance either in conquering the difficulties or in avoiding the dangers which we encounter in the great field of probabilities in which we live." It is, therefore, mere phraseology to say that "The leading characteristic of mathematics is that it deals with properties and ideas which are applicable to things just because they are things and apart from any particular feelings, emotions, or sensations in any way connected with them." (Whitehead). It is precisely the truth that mathematics deals with truth in the abstract that it is so largely inapplicable to questions in which the very best judgment can only represent an approximation to the ideal but nevertheless workable truth. Or, as Sir William Hamilton remarks, "Of observation, experiment, induction, analogy the mathematician knows nothing," yet it is of all these that organized knowledge must take cognizance if it is to serve the useful purpose of advancing the truth by which men live.

I can not for the present enlarge upon this view, recalling, however, the previously quoted remark of Professor David Starr Jordan that "The final test of the truth is its livableness, the degree to which we may trust our lives to it." No theory of probability, however useful in perfecting contingency calculations, can be safely applied to the countless questions upon which facts and mere facts alone will permit of a judgment "to which we may trust our lives." No mathematical figments can make up for deficiencies in knowledge of fundamental truth.

Limitations of space preclude an adequate discussion of the methods pursued in the organization of the library and information service of my office. The methods of organizing knowledge must necessarily vary in detail with the nature of the subject matter, but in my own experience of thirty years I have found no difficulty whatever in gaining a reasonable degree of control over a wide range of essentially different sets of facts and data, systematically arranged upon the principles of easy accessibility, completeness of experience as to time and place and reasonable economy in expense. All general information in my office other than such as is represented by books and pamphlets is first filed under a uniform envelop system arranged, however, in precisely the same manner as the books and pamphlets on the subject index plan.

The classification adopted rests upon the conception that the basis of modern progress is essentially economic, but the term economics is used in the broadest sense and made to include social and allied sciences and activities. The first division of organized knowledge in use in my office bears, therefore, the title "Economics." Under the second division is comprehended "Statistics and Information"; this section is sub-divided into United States and Foreign Countries. Both of these sections are sub-divided into about thirty minor divisions, which readily admit of being enlarged, if occasion should require; but I have found it more advantageous to avoid too many minor sub-divisions, so as to make the indexing of the information as automatic as possible. The fourth section is entitled "Labor and Industry," being practically technological, having to do with all industrial processes, labor conditions, occupational diseases, occupational accidents, etc. The fifth section bears the title "Public Health," but this is limited to the United States, simply as a matter of convenience, for in the general statistical information section public health is Sub-section 8, including, of course, vital statistics. The sixth and last section bears the general title "Science, Medicine and Research," including a vast range of more or less allied subject matters.

Throughout "information" consists chiefly of

newspaper clippings, magazine articles, articles from technical periodicals, etc. Priority throughout is given to original sources of information, including any and all official reports, documents, etc., of value. Aside from the foregoing, there is a section on Graphics, which is becoming a matter entitled to separate consideration, on account of the growing demand for graphic publicity of social, medical and economic experience. As thus conceived, the organization of knowledge can be brought within the compass of six general divisions, which can easily be memorized and into which numerous special sub-divisions fit automatically on the principle of associated ideas.

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AMERICAN BIOLOGICAL STAINS COMPARED WITH THOSE OF GRÜBLER

IN a recent article[1] the writer called attention to the need of standardizing biological stains now that those of American manufacturers are on the market. In this article mention was made of the fact that the American stains had a rather bad reputation among biologists not necessarily because of their actual poor qualities, but merely because they are different from the Grübler stains which were standard before the war. It was stated at this time that the Society of American Bacteriologists was beginning an investigation of the American stains, and the cooperation of other scientific bodies was urged. Since the article in question was written much cooperation of this kind has been secured and the work has been put on a much broader basis. For this reason it seems well at the present time to insert in these pages a brief report on progress, particularly since many interesting results have already been obtained in comparing the various brands of stains.

Still more recently there appeared in this journal[2] a statement as to a project of the National Research Council on the standardization of biological stains. This work of the National Council is the out-growth of the investigations already made by the bacteriological society. Several of the national scientific organizations, notably the Botanical Society of America and the American Society of Zoologists, are already taking active part in the work. As a result there are now some forty bacteriologists who have taken part in the bacteriological tests of the stains, about fifteen zoologists who are examining certain stains for cytological and other histological work, and it is expected shortly to have a similar group of botanists taking part in the work. The hearty cooperation of all of these investigators, located in many different institutions all over the country, is one of the most pleasant surprises the work has brought out. The tests involved are often quite time-consuming and the willingness of the collaborators to carry them out without question of remuneration or credit for the work is felt to show that biologists in general are keenly interested in the subject. Without their eager cooperation the work would have been impossible, and much credit is due to all of them.

The work has brought out quite plainly that three series of tests are necessary in standardizing any particular stain: first it must be tested for bacteriological staining; second for histological staining; and third its chemical composition must be determined so far as the present status of dye chemistry makes this possible. At present three stains or groups of stains have been tested from the bacteriological standpoint: fuchsin, methylene blue, and the gentian and methyl violets. Of these, methylene blue and gentian violet are now being tested in histological work. In addition to these, histological tests are being made of safranin, hæmatoxylin, orange G and eosine. Chemical work, through the cooperation of the Department of Agriculture in the Color Laboratory, under Dr. Ambler, has been done on methylene blue, and similar tests are shortly

[1] H. J. Conn, The Production of Biological Stains in America, SCIENCE, N. S., 53: 289-290.

[2] The Standardization of Biological Stains, SCIENCE, N. S., 53: 289-290, 1921.

to be made of gentian violet. Although the work has only just begun, enough information has already been obtained so that certain public statements can safely be made.

In the first place, it has been learned that there is no justification for implicit faith in the Grübler stains. They are apparently not nearly as pure as those that are now made in America. It has for a long time been well known that certain Grübler stains were cut with inert material such as dextrin or salt, and the recent chemical tests that we have made show very plainly the greater percentage of color in nearly all the American samples examined. Possibly in some cases the greater concentration of the American stains may have been the cause of the poor results obtained with them, since the directions for preparing staining solutions are all based upon the Grübler stains. In the second place, it has been found that the Grübler stains are not as constant or uniform as it used to be supposed. Some examples of Grübler's methylene blue for example are entirely satisfactory for staining dried milk smears, while other samples, the authenticity of which can not be questioned, have the property of dissolving casein and washing the milk smears off of the sides. Furthermore, certain Grübler samples of orange G prove entirely satisfactory in the Fleming triple stain while other samples are very unsatisfactory, ranking with the poorest American samples in this respect. It has been noticed with much interest that when an investigator has been using for histological purposes a sample of some Grübler stain from his own laboratory, and also various unknown samples sent to him, in which another Grübler sample was included, he has invariably reported his own sample of the Grübler stain as much superior to the unknown sample. From this it has been concluded that the Grübler stains vary as much as the American stains and that a histologist naturally reports best results with that particular sample with which he has had experience.

As to the qualities of American stains, it can be said without hesitation that they are in general very good. This is particularly true of the bacteriological stains, to which for one reason or another the manufacturers have given most attention. Certain American methylene blues, in particular, are decidedly superior to any we were used to before the war. This statement is made on the basis of very severe bacteriological tests and of chemical analyses as well. There seems to be no question but that it will be possible to find American-made stains of practically all kinds desired by biologists as good or even better than those obtained from abroad.

The chief uncertainty in the situation at present is whether the producers of the stains will stay in the business. This matter may be settled one way or the other by action of Congress before this paper appears in print; but whatever is done in the matter, it is decidedly to be hoped that certain of the American stains which some of us biologists now invariably choose in preference to the Grübler products, will continue to be available to us.

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Committee on Standardization of Biological Stains, National Research Council
GENEVA, N. Y.,
JANUARY 15, 1922

SCIENTIFIC EVENTS

THE STANDARDIZATION OF INDUSTRIES

BILLIONS of dollars can be saved by American industry if a comprehensive program of standardization is carried out, according to E. C. Peck of Cleveland, O., chairman of the standardization committee of the American Society of Mechanical Engineers. Mr. Peck writes:

> The German work is of special interest to those responsible for the management of American industries, not only because of its importance, but also because of the similarity in the historical conditions surrounding the national standardization movements in Germany and in America.

Mr. Peck says that mass production is no longer primarily an American development, but that the lesson of the war has brought home to European countries realization of its significance, so that to-day in these countries far reaching programs of industrial standardiza-

tion are being carried out. These countries are employing systematic cooperative effort of industries functioning through national industrial associations, technical societies and government bureaus.

It behooves managers of American industries to intensify their efforts toward standardization or they will be left behind in the competition for world commerce. It is not enough that there be standardization work done by sections of industries and by individual firms, although such work, prior to the war, made possible a considerable amount of mass production, which attracted the attention of European industrialists.

To reap the full benefits the work must be broadened and intensified, and made national in its scope. This requires the joint effort of manager and engineer, of producer, distributor, consumer and independent specialist, all speaking through the organized bodies which represent their interests.

The many benefits of standardization are by no means limited to the production side. In the long run standardization is bound to be of even greater importance in the reduction of distribution and selling costs,—perhaps the most important problem of our economic system. A comprehensive program of standardization planned and carried out by our great national industries will mean the saving of hundreds of millions—even billions of dollars.

The American Society of Mechanical Engineers will take up the question of standardization and research at a five-day meeting to be held in Atlanta, Ga., beginning on May 8. The society in its statement on German progress says:

The standardization movement in Germany is particularly significant, since Germany is one of the three leading industrial countries. The industries of Austria, Holland, Sweden and Switzerland are so intimately related to those of Germany on account of geographical and other relationships that they are necessarily affected very largely by developments in Germany.

It appears that the work is being woven very intimately into the industrial fabric. The very large number of standards purchased by the industry, and the fact that the central organization has 5,000 firms which are cooperating members, are a sufficient indication of this.

There seems to be a striking analogy between the present standardization movement in Germany and the research movement developed there a generation ago. Whatever estimate one may place upon the rôle it played in German industries generally, every one agrees that research was fundamental in the development of their great chemical industries. The rôle which the Germans are expecting standardization to play in all their industries would be not unlike the rôle which research has played in their chemical work.

MORE "GLASS FLOWERS" AT HARVARD

THE *Harvard Alumni Bulletin* states that Rudolph Blaschka, the artist who, at Harvard, with his father, modelled the famous "glass flowers" in the Botanical Museum at Harvard University, has begun work on a supplementary collection of glass models of grasses and sedges, which will be displayed on their completion in a room adjoining the Ware collection of glass flowers. Walter Deane, 70, formerly president of the New England Botanical Club, has consented to aid in providing Herr Blaschka with American material for the construction of the new models.

The Ware collection now on exhibition will be practically complete when twenty models and fifty magnified anatomical details, now in the artist's studio in Germany, have been transported to this country. It is unsafe to transport them under existing conditions, especially since their removal to Boston cannot yet be secured "in bond." Up to the time of the war the glass flowers were shipped direct to Boston and then, by the courtesy of the Custom House officials, were carried directly to the Museum in Cambridge and were unpacked safely at the University.

The collection now illustrates 160 families of flowering plants, 540 genera, and 803 species, and there are more than 3,200 analytical magnified details. The range of the exhibition is sufficiently extensive to give a clear idea of the relations of these important families and species to each other. The skill which has copied in glass every minute detail of structure of the plants has been devoted solely to Harvard University. All of the specimens which have been made since 1895 are the artistic handiwork of Rudolph Blaschka, who has carried on all of his study and his modelling single-handed in his studio in Germany.

THE NEW BUILDING FOR FORESTRY AT YALE UNIVERSITY

YALE'S new Forestry School building will cost about $300,000 and will be situated on Prospect Street, on the Sage-Pierson Square, on which several large laboratories are being erected, including the Osborne, Sloan, Harriman and Sterling structures. It is the gift of William H. Sage of Albany, a member of the Yale class of '65. The architect is William Adams Delano of New York City, Yale, '95.

The ground slopes from north to south abruptly and advantage has been taken of this fact to gain a full lighted story in the basement. While the building is three stories high at the north, it is practically four at the south.

The building will conform in architectural treatment and material with the others on this quadrangle. It will be of fireproof construction, with slate roof. The ground floor will contain the Forest Club room with a fireplace and ample windows to the west. Wood for the panels has been offered by the New York Lumber Trade Association and a great variety of woods will be used without destroying the architectural quality of the room. On the same floor will be the laboratory for testing woods, requiring heavy machinery and solid foundations.

On the first floor is the library, a room 24 by 40 feet and 14 feet high, which will be divided into alcoves by book cases. This will be purely a departmental library. On this floor will also be the administrative offices, and a large lecture or assembly room to seat about 150 people.

On the second floor will be two class rooms, a drafting room and a silver-culture laboratory, besides private work rooms for the staff. The top floor under the roof will be well lighted by skylights and will give ample working space for the main laboratory, the herbarium, and wood collections, and some special research rooms.

The corridors on the library and top floors have been made amply wide to give room for cases of specimens. They serve, therefore, the double purpose of corridor and museum. A freight elevator in the southeast corner accessible from the roadway will make it possible to lift heavy objects to every floor.

THE WASHINGTON CONFERENCE ON PUBLIC HEALTH

THERE was held this week under the auspices of the United States Public Health Service in Washington a conference of deans of schools of public health and medical schools, presidents of universities with which these schools are connected, a selected number of professors of public health subjects and men actively engaged in public health work, on "The Future of Public Health in the United States and the Education of Sanitarians."

After considering the present status of the public health movement and present facilities for the education of health officers and other sanitarians, the conference considered various newer aspects of public health and their importance in the training of sanitarians; the various kinds of sanitarians which will be needed for the future; the recruiting and training of more and better sanitarians; and the various problems connected with the training of sanitarians for the future and the further education of those who are now employed in public health work.

Among those expected to take part in the conference were Presidents James R. Angell, Livingston Farrand, Frank J. Goodnow, Ray Lyman Wilbur; Deans Hugh Cabot, William Darrach, David L. Edsall; Professors Allen W. Freeman, E. O. Jordan, Roger Perkins, Mazyck P. Ravenel, Milton J. Rosenau, George C. Whipple, Jesse F. Williams, C.-E. A. Winslow; Drs. Lewellys F. Barker, Walter H. Brown, John A. Ferrell, Lee K. Frankel, Otto P. Geier, Frederick R. Green, Vernon Kellogg, John H. Stokes, Victor C. Vaughan, George E. Vincent, William A. White, Hubert Work, also Drs. S. J. Crumbine, Hugh S. Cumming, Eugene R. Kelley, L. L. Lumsden, A. T. McCormack, A. M. Stimson and Allan J. McLaughlin, of the United States Public Health Service and the various state boards of health.

The announcement of the meeting says:

The rapid development of the public health movement in the United States, the shortage of trained public health officers and the present inadequate facilities for their education has brought about a situation which, in its opinion, merits a thorough consideration not only by lead-

ers in the public health movement but by university presidents and others who are now participating in the education of youth. Numerous surveys have called attention to the need for more and better trained health officers. On the other hand, there has never been so much interest among people generally in public health as there is at the present time. Could there be made available a larger number of trained public health officers, it would be possible within a comparatively short period of years to immeasurably increase the health, efficiency and happiness of the American people. From these considerations it appears that the problem of the education of health officers is a matter perhaps more important in its many implications than any other now before physicians and educators.

SCIENTIFIC NOTES AND NEWS

THE spring meeting of the American Chemical Society will be held with the Alabama Section at Birmingham from April 3 to 7. Dr. Edgar F. Smith will preside. Among the special addresses are the following: "The pioneer's field in petroleum research," by Van H. Manning; "Informational needs in science and technology," by Charles L. Reese, and "Recent developments of the chemistry of rubber," by W. C. Geer.

ON February 24 Vilhjalmur Stefansson delivered a lecture before the National Geographic Society. On that occasion the society made the announcement that its Research Council had awarded him the Grant Squires prize "in recognition of the unique interest and importance of his book, 'The Friendly Arctic,' the outstanding geographic publication of 1921."

THE King of Italy has conferred upon Col. Lawrence Martin, of Washington, D. C., formerly professor of geography at the University of Wisconsin, the rank of Officer of his Order of the Crown of Italy for services during the war.

AT a celebration which took place at the Sorbonne on January 22 Professor Henry Le Chatelier was presented with a gold medal in commemoration of his fifty years' work of scientific and technical research.

WE learn from *Nature* that the first award of the Meldola medal has been made by the council of the British Institute of Chemistry, with the concurrence of Dr. Percy E. Spielmann, representing the Maccabæans, to Dr. Christopher Kelk Ingold.

MR. A. S. KENNARD has been elected president of the Malacological Society of London. The vice-presidents are Mr. J. R. le B. Tomlin, Professor A. E. Boycott, Mr. G. K. Gude and Mr. C. Oldham.

DR. FRANCIS WELD PEABODY, assistant professor of medicine at the Harvard Medical School and physician of the Peter Bent Brigham Hospital, has been appointed director of the Thorndike Memorial Laboratory, which is being erected on the grounds of the Boston City Hospital. The laboratory will be completed in less than a year and will be devoted mainly to research work.

PROFESSOR THEODOR SVEDBERG, who holds the chair of physical chemistry at the University of Upsala, has accepted the invitation extended to him by the University of Wisconsin to deliver a course of lectures at the University during 1923.

P. J. WESTER, for seven years horticulturist, and the last four years agricultural adviser to the Bureau of Agriculture, Philippine Islands, has applied for retirement from the government service under the Osmeña Act, and is returning to the United States.

H. A. DOERNER has been assigned to rare-metal work at the Reno experiment station of the U. S. Bureau of Mines. Mr. Doerner was former connected with the Denver office of the bureau. J. A. Cullen has been assigned to cement experiment work at the Columbus Station.

L. G. LENNERT, assistant sanitary engineer, United States Public Health Service, has been granted leave of absence to serve on the International Health Board during 1922. He will have headquarters in Sacramento, Calif.

IVAR HERLITZ, fellow of the American Scandinavian Foundation, formerly with the Southern Sierras Power Company, Riverside, Calif., is studying high-voltage transmission problems under a research scholarship from the Swedish Academy of Engineering Science.

GEORGE T. SOUTHGATE, formerly research engineer with the American Cyanamid Company at Brewster, Fla., has accepted a position in the Bureau of Soils, United States Department of Agriculture, Washington, D. C.

DR. CHARLES WILLIAM DABNEY, who retired from the presidency of the University of Cincinnati a year ago, has established an office in Houston, Texas, where he and his associates are prepared to report on mineral, oil and other properties.

DR. RAYMOND PEARL gave an illustrated lecture on "The growth of population" before the War College in Washington on March 6.

DR. JOHN A. WIDTSOE, formerly president of the Utah Agricultural College and later of the University of Utah, is delivering a series of lectures at the Brigham Young University on "The making of science."

PRESIDENT WALTER DILL SCOTT, of Northwestern University, formerly professor of psychology, will give the convocation address at the one hundred twenty-fourth convocation of the University of Chicago on March 21. His subject will be "Handling men."

RECENTLY, under the auspices of the department of physics of the School of Mines and Metallurgy, Rolla, Missouri, Professor S. R. Williams, of Oberlin College, spoke to the students of the department of physics on "The principle of Bernoulli and some of its applications"; to the Science Club on "Magnetic-mechanical analysis of ferromagnetic substances," and at chapel on "The spirit of scholarship."

DR. OTTO KLOTZ, director of the Dominion Observatory, delivered an address before the Brooklyn Institute of Arts and Sciences on "Astronomy in Canada" on February 28.

PROFESSOR H. E. ARMSTRONG, who has consented to deliver the first Messel Memorial Lecture at the forthcoming annual meeting of the Society of Chemical Industry, has chosen as the subject of his discourse, "Rhapsodies culled from the Thionic Epos, including a discussion of the conditions determinative of chemical interchange."

DR. MAJOR GREENWOOD, Milroy lecturer befor the Royal College of Physicians of London, had for the subject of his lectures on March 9, 14 and 16, "The influence of industrial employment on general health." The Goulstonian lectures to be given by Dr. Anthony Feiling, on March 21, 23 and 28, will deal with the interpretation of symptoms in disease of the central nervous system. Dr. Hector Mackenzie's Lumleian lectures on diseases of the thyroid gland will be delivered on March 30 and April 4 and 6.

WILLIAM JAMES COMSTOCK, for many years instructor of organic chemistry at the Sheffield Scientific School of Yale University, died on January 24, at the age of sixty-two years.

GEORGE LYMAN CANNON, for thirty-four years instructor in biology and geology in the Denver high schools, author of contributions to geology and natural history, died on February 15, at the age of sixty-two years.

THE death is announced at the age of forty-two years of Professor Erich Ebler, professor of inorganic and analytical chemistry in the newly founded University of Frankfort-on-the-Main.

AN appropriation of $34,978,033, to meet expenses of the Department of Agriculture during the coming year is recommended in a bill reported on March 6 by the House Appropriations Committee. The total is $3,710,026 less than the amount appropriated for the current fiscal year and $1,554,683 less than budget estimates.

THE defeat of the Ellis evolution bill by the Kentucky House of Representatives by a majority of one vote on March 10 finally disposed of the question at this session of the legislature. The Rash bill in the Senate recently was recommitted and the rules committee refused to allow it to be reported. The Ellis bill would have forbidden the teaching in the University of Kentucky, the normal schools and the public schools of "Darwinism, atheism, agnostics or evolution as it pertains to the origin of man." It was the first of three similar bills introduced this season, two in the House and one in the Senate. The other bills can not be passed,

as the legislature was expected to adjourn on March 15.

ANNOUNCEMENT is made from the University of Chicago that Dr. H. A. Lorentz, professor of physics in the University of Leiden, will lecture at the Ryerson Physical Laboratory on March 17 and 18 on "The constitution of matter," on April 3 on "The theory of spectral lines" and on April 4 on "The Theory of relativity." It is also announced that the following graduate courses in theoretical physics will be given during the coming summer quarter at the University of Chicago: "The electrical properties of gases," by Professor H. A. Wilson, of Rice Institute, Texas; "Thermodynamics, radiation and the Quantum Theory," by Professor W. F. G. Swann, of the University of Minnesota, and "Relativity and the Electron Theory," by Assistant Professor Leigh Page, of Yale University. Associate Professor A. C. Lunn, of the University of Chicago, will give courses on "Vector analysis" and "Satistics and probability."

As has already been noted in SCIENCE, Professor Solon I. Bailey of the Harvard Observatory, accompanied by Miss Annie J. Cannon, sailed from New York on February 28 for Peru to take charge of the Harvard Southern Astronomical Station at Arequipa. The *Harvard Alumni Bulletin* says: The work of the Arequipa station, which has been somewhat reduced in scope in recent years, is expected to take on a new importance with the return of Professor Bailey, who was instrumental in its establishment over thirty years ago and served for a long time as its director. He plans to spend the next two years in Peru. In addition to supervising the routine affairs of the station he will continue his studies of the globular star-clusters. Miss Cannon, whose achievements in the investigation of stellar spectra recently won for her an honorary degree from Groningen University in Holland, will remain at Arequipa for several months, and will be occupied largely in photographing the faint stars in the Southern Milky Way in order to classify their spectra."

THE second series of free public lectures on medical subjects and public health, given under the auspices of the Division of University Extension of Washington University by the faculty of the School of Medicine, concluded on March 12. These lectures have been given on Sunday afternoons to an audience averaging two hundred, and have received considerable newspaper publicity. The subjects for the year have been as follows: "Smallpox and vaccination," Dr. George Dock, professor of medicine; "Food and vitamines," Dr. Philip A. Shaffer, professor of biological chemistry; "Syphilis and its results," Dr. Martin F. Engman, clinical professor of dermatology; "The value of a university hospital to the community," Dr. Ernest Sachs, professor of clinical neurological surgery; "Overweight and health," Dr. William H. Olmsted, associate in clinical medicine; "Anthropology in medicine," Dr. Robert J. Terry, professor of anatomy; "Mental hygiene and education," Dr. Sidney I. Schwab, professor of clinical neurology; "What has surgery accomplished?" Dr. Evarts A. Graham, professor of surgery; "Home treatment of minor injuries," Dr. Barney Brooks, associate in clinical surgery.

THE British Medical Research Council has appointed the following committee to report upon the promotion of researches into the biological action of light with the view of obtaining increased knowledge of the effects of sunlight and other forms of light upon the human body in health or disease: Professor W. M. Bayliss (chairman), Mr. J. E. Barnard, Dr. H. H. Dale, Capt. S. R. Douglas, Sir Henry Gauvain, Dr. Leonard Hill and Dr. J. H. Sequeira. Dr. Edgar Schuster is secretary of the committee. The council recently announced that its total resources have been reduced and that it must omit the prosecution of researches which would have indubitable scientific value toward the advancement of preventive or curative medicine. The Medical Research Council, in cooperation with the Ministry of Health, the Board of Health for Scotland and the Ministry of Health for Ireland, was formed for the investigation of tuberculosis, nutritional diseases, food poisoning and dental decay, and the treatment of veneral disease, or rheumatism and allied diseases, and of mental disorders.

UNIVERSITY AND EDUCATIONAL NOTES

IT is announced that Vassar College plans to erect two new buildings, a $150,000 physics laboratory and a $100,000 alumnæ building.

IT is announced from Brussels that a legacy of $100,000 goes to Louvain University, Belgium, for the erection of a special building for cancer research.

DR. HARLOW SHAPLEY, who was appointed director of the Harvard College Observatory last fall, has been elected to the Paine professorship of practical astronomy, which has been vacant since the death of Professor Edward C. Pickering, in 1919.

DR. CHARLES W. FLINT will be installed as chancellor of Syracuse University on June 15.

PROFESSOR FRANCIS HARTMAN has recently been elected dean of the Day Technical School of Cooper Union, New York City. This appointment is in recognition of his long service at that institution as head of the department of physics and electrical engineering.

DR. RALPH A. WALDRON, formerly instructor in Pennsylvania State College and the University of Pennsylvania, has been elected professor of biology in Thiel College, Greenville, Pa.

E. W. MARKLE, who has been connected with the educational and recreational work of the United States army as principal and senior instructor of the electrical department, vocational schools, Camp Funston, Kansas, has been appointed assistant professor of electrical engineering at the Agricultural and Mechanical College of Texas.

DISCUSSION AND CORRESPONDENCE

HAVE THE STREAMS OF LONG ISLAND BEEN DEFLECTED BY THE EARTH'S ROTATION?

DURING the summer of 1920 Mr. Henry Hicks, of Westbury, Long Island, pointed out to me the very interesting difference between the east and west banks of one of the short streams flowing across the almost flat southern slope of the island. Looking west across the almost imperceptibly sloping eastern bank of the stream-way one sees the western bank rising quite steeply and very much resembling a railroad embankment in height and steepness.

This peculiar situation has long been accepted rather generally by geologists and physiographers[1] as due to the westerly deflection of streams by the earth's rotation. However, when one considers the weakness in flow of these streams, their very slight fall, and the fact that they are mostly less than ten miles long, serious doubts arise.[2] To one who, like the writer, has studied the cumulative effects of wind and vegetation upon wind-borne materials, it appears very probable that the deflective effect is very slight as compared with the resultant effects of these other agencies.

During glacial times and for some time afterwards there must have been, during dry weather and at times of high winds, a considerable movement of loose residual sands and glacial materials over the flat plain south of the terminal moraine which forms the backbone of Long Island. The general southwesterly winds would deposit their main load on the lee-side of any north-south trending bank and this deposition would be augmented and the drifting materials held by the denser vegetation of the moister stream margin. Probably tundra prevailed here for a long period during glacial times and, even yet, the region has not been entirely covered by forest, so that the effects of the notoriously strong winds of the South Shore would have been greater in the past than at present. It is suggested that someone make a careful study of a cross-section of one of these steeper west banks to determine the nature of the deposit and whether it may have been built as is here suggested.

O. E. JENNINGS
PITTSBURGH, PA.

[1] Lewis, Elias, Jr., *Am. Journ. Sci.*, 3rd Ser., 13: 215-216, 1877.

Gilbert G. K., op. cit., 27: 427-432, 1884.

Fuller, Myron L., "The Geology of Long Island," U. S. G. S., Prof. Paper 82: 9, 10 and 50, 1914.

[2] See also in this connection, Geikie, Sir Archibald, *Encycl. Brit.*, 11th edit., 11: 649, 1910.

LEGISLATION TO SUPPRESS TRUTH

TO THE EDITOR OF SCIENCE: When Professor Morgan stated in his "Critique of Evolution" that the old conflict between science and theology over the question of evolution vs. special creation was ended and that it was unlikely it would ever again be revived, he was evidently not informed of a condition prevalent throughout most of our southern and western states. The newspapers report a bill before the Kentucky legislature making the teaching of evolution an offence punishable by a fine of $500 to $1,000. This action is more than a possibility elsewhere, since the Oklahoma State Baptist Association recently passed a resolution condemning evolution, and appointed a committee to eradicate this "heresy" from their schools in this state. The Texas Southern Baptists in a convention at Dallas recently took the same action. A similar movement was inaugurated in December by a "Congress" of the Disciples of Christ, where in discussion bitter hostility was shown and a committee was appointed to investigate all the colleges under the auspices of that body with a view to withholding funds from any which may be found to "teach evolution." In both of these denominations, the religious periodicals are carrying pages of fulminations against evolution ("Darwinism"), often of the most antequated and puerile matter, but calculated to arouse the frenzy of the uninformed who imagine their religious beliefs to be imperilled by this "damnable doctrine"! The secular press in this same region of the country has in several cases carried editorials commending the action in Kentucky and urging like action elsewhere.

This is not a time when the scientific world should regard the situation as a joke, nor merely as a local manifestation. With a "silver-tongued" apostle, the recrudescence of the old conflict bids fair to take on the proportions of a general action. The Moody Biblical Institute of Chicago, it is reported, is sending thousands of Mr. Bryan's addresses through the mails in furtherance of this propaganda. When it is realized that 50 per cent. of our citizenship are known to have the intelligence of mere children the harm that these misguided reformers may do is beyond calculation.

X.

ECOLOGICAL INVESTIGATION ALONG THE RED RIVER

TO THE EDITOR OF SCIENCE: On page 127 of the February 3, 1922 number of SCIENCE you published a news item which included extracts from a letter of the Attorney General of the United States justly commendatory of Professor Cowles "for his ecological investigations along the Red River for use in connection with a suit between the states of Oklahoma and Texas in the Supreme Court of the United States."

The reader might gather from this that the suit referred to was strictly a two-sided one between these two states and that the government of the United States (including the attorney general) were a disinterested, unpartisan referee in the matter. Such an impression the attorney general certainly did not mean to convey, for the United States is an intervener in the suit. When the evidence is made available to the scientific public it will have to be read with this in mind.

CARL HARTMAN

AUSTIN, TEXAS

ATOMIC NUCLEI

In my address printed in SCIENCE on March 3 last, the following corrections should be made:

1. In the last line of page 225, 3×10^{-13} cm. should read 3×10^{-12} cm.

2. In the fifth line, column 1, of page 226, 3×10^{-13} cm. should read 3×10^{-12} cm.

3. In the twenty-seventh line, column 1, page 226, 3×10^{-12} cm. should read 3×10^{-13} cm.

These errors were made in the copy and inadvertently overlooked by me in the proof.

J. C. MCLENNAN

THE PHYSICAL LABORATORY,
UNIVERSITY OF TORONTO,
MARCH 7, 1922

NOTES ON METEOROLOGY AND CLIMATOLOGY

NEW DISCUSSION OF TEMPERATURES IN THE UNITED STATES

ORDINARILY, the dullest portion of a scientific paper is that in which tables and charts

are described. But a significant exception to this rule is to be found in Professor Robert DeC. Ward's recent discussion of the new temperature charts of the United States.[1] In this paper, Professor Ward has woven about certain fine charts, which are to appear eventually in the section on "Climate" in the *Atlas of American Agriculture* (U. S. Department of Agriculture), a moving story of isotherms so fascinating that one reads to the very end without the least fatigue;—this is noteworthy because it is exceedingly difficult for most authors to avoid the prosaic when dealing with such a subject. But the dynamic qualities of the paper are not more impressive than the skill displayed in drawing from the isothermal complex, the broad and significant climatic features of these extraordinary charts.

From a large number of charts furnished the author through the courtesy of Dr. O. E. Baker, Professor C. F. Marvin, and Mr. J. B. Kincer, twenty have been selected for discussion and are reproduced as lithographs in the *Monthly Weather Review*. The charts include monthly means for each of the twelve months, average winter temperatures, mean annual ranges, lowest mean monthly temperatures recorded in January and July, absolute maxima and minima, and average annual minima. These represent a distinct advance over earlier charts in that topography has been carefully considered. The mountainous west, therefore, on most of the charts, presents a very complex appearance, for there the influence of altitude is most clearly shown. The river valleys, such as those of the Rio Grande and the Colorado, could be readily detected by the trend of the isotherms were the base map lacking; the Appalachian region introduces warping and many local irregularities. The crowding of the isotherms in the Rocky Mountains, however, prevents such broad generalizations as are possible in the East.

[1] Some characteristics of United States temperatures. *Monthly Weather Review*, November, 1921, pp. 595-606. A limited number of reprints of this article will be available shortly, and may be obtained upon application to the Chief of the Weather Bureau, Washington, D. C.

Beginning with a broad, world-view of the trend of isotherms across the continents, the author shows how the great ocean currents crowd the isotherms in latitude on the east coasts and spread them apart on the west coasts. This accounts for the mild climate of the west coast of Europe as compared with the east coast of the United States. In middle and lower latitudes, the east and west coasts of the United States do not differ materially in mean annual temperature, but in northerly latitudes, the mildness of the Pacific Coast asserts itself. In latitude 45° N., for instance, the mean annual temperatures are about 10° F. higher on the west than on the east coast; while San Diego, Calif. and Charleston, S. C., in the same latitude, have approximately the same mean annual temperature.

A striking feature of the mid-winter chart is a southward curving of the isotherms over the northern interior districts, "which emphasizes, among other things, the fact that the western border of the Great Plains and the eastern foothills of the Rocky Mountains are warmer in spite of their greater elevation than the lower-lying country farther east." Prevailing off-shore winds along the Atlantic and Gulf coasts prevent the full effect of the moderating influence of these warm waters to be realized. But, in spite of this, the isotherms bend in general accord with the coast lines. The moderating effects of water are also observed to leeward of the Great Lakes. Along the Pacific coast, on-shore winds cause the isotherms to parallel the coast, thus affording an interesting comparison of the effect of prevailing winds and latitude controls, the Atlantic coast being conspicuously subject to the latter.

The January mean temperature is much higher on the west coast than on the east, increasing, as was the case with the mean annual temperature, in effectiveness with increase of latitude. The coast of Oregon is 20° F. warmer than the corresponding latitude on the Maine coast. The direction of the pilgrimages of seekers for balmy climates, the shifting of transportation from the Great Lakes to railroads upon the close of navigation, the

seasonal control of certain industries, are only suggestions of the many economic considerations dependent in a large way upon the geographical distribution of monthly mean temperature.

In mid-summer, however, the south to north gradients of temperature in the east are not so marked as in winter. "So far as the mean temperatures alone are concerned, therefore, a long journey from south to north in search of decidedly cooler summers gives far less change than the corresponding trip from north to south in winter in search of much warmer and balmier climates." Three features of Pacific coast temperatures are interesting: (1) the slight north-south gradient of only 1° F. per 100 miles along the coast; (2) the extremely steep gradient from the cool coast of southern California to the heated interior; and (3) the contrast between heated valleys and cool slopes.

But it is in his discussion of the annual march of the isotherms that Professor Ward waxes especially cinematographic, for one can see the northward and southward march of the isotherms as vividly as if they were projected upon the silver sheet. As the winter advances these isothermal lines appear in northerly latitudes and glide smoothly and continuously equatorward, and later begin their poleward migration, sometimes leaving the earth's surface entirely in higher latitudes, and rising into the free-air. This is the author's conception of the interpretation of such charts, and concerning it, he remarks:

> When this conception is thoroughly in mind, isothermal maps have a new meaning. They are no longer dead and rigid, but are full of movement, suggesting an infinite number of relations between the everchanging temperature and all of human life and activity.

The temperature gradient in January from southern Florida to Laborador is the steepest in the world, when the great distance is considered. This steep gradient, especially unique because there are no transverse mountain ranges to produce it, has great economic significance, as was first pointed out by Woeikof. Labrador is arctic in climate, while Florida in many respects is tropical. This favored the prosperity of the early colonists and remains of the greatest economic significance.

The final portions of the paper deal with many questions of considerable popular interest. Upon what does our judgment of an abnormally cold or warm month depend? Certainly, our senses are not capable of averaging a month's temperatures so that they can conclude that this month or that was abnormally warm or cool. Such opinions, it seems, are based upon extreme "spells" of weather, their severity, and their distribution.

What is the physical cause underlying the sequence of unusually mild or cold seasons? Such abnormalities have been noted since the earliest times and have been studied by Schott, Stockman, and Henry, and more recently by Dr. C. F. Brooks. The first three showed that no permanent change of temperature is taking place. Dr. Brooks has shown that no other than a chance relationship has existed during four fifths of the years from 1812 to the present; the remaining fifth is represented by two series of alternating cold and warm winters attended by similar preliminary seasons. These series begin with 1872-73 and 1917-18, and are of especial interest in connection with their bearing upon generalized long-range forecasting.

What are the highest and lowest temperatures ever observed at various stations in the United States? "Zero has not been recorded on the Atlantic Coast south of Chesapeake Bay, on the immediate Gulf Coast, or in the Valley of California." In the northern Plains −60° F. has been recorded. At Greenland Ranch, in the Death Valley, a temperature of 134° F. was measured. Key West, Fla., is the only regular Weather Bureau station that has never recorded a freezing temperature.

Finally, there is the question of the validity of certain beliefs that there are irregularities in the annual march of temperature which tend to persist. The "January thaw," the "May freeze" and "Indian summer" seem to have no counterpart in the annual march of temperature, according to Professor C. F. Mar-

vin and the New England "Ice Saints" (May 10) seems to be a similar fiction, according to the late Waldo E. Forbes. Where such irregularities appear in the mean of a number of years, they appear to be the result of one or more extreme occurrences.

The well-merited praise that Professor Ward bestows upon the new temperature charts of the *Atlas of American Agriculture* could equally well be turned by others upon his own splendid discussion of them.

C. LEROY MEISINGER

WASHINGTON, D. C.

SPECIAL ARTICLES

THE PRODUCTION OF NON-DISJUNCTION BY X-RAYS

IN a previous issue of this journal[1] the writer described certain experiments which showed that the X-chromosome could be "eliminated" from the egg of Drosophila by X-rays. In these experiments red-eyed, homozygous, virgin females were X-rayed and crossed with white-eyed males. A total of twenty-four exceptional sons (white-eyed) were produced by the X-rayed females; fourteen out of the nineteen fertile X-rayed females producing exceptions. All excepting one of the twenty-four exceptional sons obtained from the X-rayed females were from eggs laid within six days of the time of X-raying and they could be divided into two groups corresponding to eggs laid during the earlier and later part of this period. Plough[2] has shown that maturation of the eggs in Drosophila melanogaster occupies approximately six days. It therefore seems probable that the X-rays act on the eggs while in one of the maturation divisions.

In the experiments referred to above only exceptional sons were recorded. In primary non-disjunction as investigated by Bridges[3] both exceptional sons and exceptional daughters occur. When, however, the female parent is homozygous for the dominant allelomorph as in the case of the X-ray experiments, the exceptional daughters are indistinguishable externally from their regular sisters.

The experiments to be described were planned to determine whether exceptional daughters were produced as a result of X-rays. Accordingly homozygous white-eyed females were crossed to eosin-eyed miniature-winged males. The regular offspring of such a cross are eosin-eyed, normal-winged daughters and white-eyed normal-winged sons. The exceptions are white-eyed, normal-winged daughters and eosin-eyed, miniature-winged sons. In the experiments, white-eyed, virgin females from stock obtained from Dr. T. H. Morgan and used in the previous X-ray experiments, were mated to eosin-eyed, miniature-winged males from stock obtained from H. H. Plough. The females used both for the controls and for X-raying, were all sisters, being from the first generation of a single pair of white-eyed flies. The virginity of these was secured by isolating pupæ in test tubes. The X-raying[4] was done soon after the flies emerged from the pupa cases and they were immediately mated. The males used in the matings were, in the greater number of the experiments, the offspring of a single pair of eosin-eyed, miniature-winged flies. (This was probably an unnecessary precaution). Seventeen of the control pairs were fertile and one pair or 6 per cent. produced one exceptional son (eosin-eyed and miniature-winged). The total number of offspring produced by the control pairs in the first generation was 1,743 females and 1,726 males and the exceptional fly formed .06 per cent. of the males. Thirteen of the X-rayed females were fertile. Nine of them or 69 per cent. produced exceptions, two daughters (white-eyed and normal-winged like their mothers) and twelve sons (eosin-eyed and miniature-winged[5] like their fathers). The

[1] SCIENCE, N. S., Vol. LIV, September 23, 1921.

[2] *Jour. Exp. Zool.*, Vol. 24, No. 2, 1917.

[3] *Genetics*, Vol. 1, p. 1-52, 107-163, 1916.

[4] The X-ray dosage and the technique of these experiments cannot be adequately described in a short note such as the present. They will be described in detail in a more extended paper to appear shortly.

[5] In the case of three of the exceptional sons the wing character was not determined. Two of them were obtained by dissecting late pupal stages and one died before its wings had expanded.

two female exceptions were the daughters of different X-rayed females. The total number of daughters produced by the X-rayed females was 512 and the two exceptions formed .39 per cent. of them. The total number of sons produced by the same X-rayed females was 467 and the twelve exceptions form 2.5 per cent. of them. It should further be noted that four of the thirteen fertile X-rayed females produced less than ten offspring and that each, *i. e.*, 100 per cent of the nine X-rayed females which produced more than ten offspring produced one or more exceptional daughters or sons.

The exceptional son of the control female was mated and found to be sterile. Eight of the twelve exceptional sons of the X-rayed females were mated and proved sterile. The other four exceptional sons of the X-rayed females were either dead when found or died soon afterwards. Bridges[3] and Safir[6] both found that exceptional males arising from primary non-disjunction were sterile. One of the exceptional daughters was fertile, the other sterile.

It is, of course, not certain that both of the exceptional daughters obtained from the X-rayed females were produced as a result of the X-rays. Safir[6], working on primary non-disjunction in white-eyed stock, found two exceptional females and thirteen exceptional males in a total of 21,773 offspring. A consideration of this and the fact that no exceptional daughters were produced by the control females and that the exceptional daughters came from different X-rayed parents makes it seem extremely unlikely that both the exceptional daughters were the result of natural non-disjunction. It is interesting to note that the unequal ratio of exceptional males to exceptional females, six to one, found in the offspring of the X-rayed females, is approximately the same as that found for natural non-disjunction in white-eyed females by Safir.

Bridges in his work on non-disjunction[3] has clearly demonstrated that the exceptional males arising from primary non-disjunction come from eggs which are without an X chromosome and are fertilized by an X chromosome bearing sperm. Such males have the chromosome formula XO. The exceptional females caused by primary non-disjunction, he shows to be due to the fertilization of an egg having two X-chromosomes by a Y chromosome bearing sperm. Such females have the chromosome formula XXY. This evidence seems to justify the assumption that the exceptional flies produced as a result of the action of X-rays have the chromosome formulas found by Bridges to occur as the result of natural primary non-disjunction; and the conclusion that an effect of X-rays when applied to eggs during maturation is to cause non-disjunction. This makes it probable that the X-rays have a direct effect on the germ cell, causing an increase in the tendency, already seen in the occurrence of natural non-disjunction, for the two X chromosomes to fail to separate in the maturation of the egg. The question as to whether this effect is due to a modification of the physical properties of the X chromosomes or of the protoplasm surrounding them will not be discussed here.

When primary exceptional females are crossed to males like their fathers they produce further exceptions. As shown by Bridges[3] secondary exceptional females occur when the two X chromosomes are included in the mature egg and exceptional males when the two X chromosomes pass into a polar body and leave only the Y chromosome in the mature egg. When the egg containing two X chromosomes is fertilized by a sperm containing a Y chromosome the resulting female lives and is like its exceptional mother. When the egg containing only the Y chromosome is fertilized by a sperm containing an X chromosome the resulting male lives and is like its father. The two exceptional daughters of the X-rayed females were mated to eosin-eyed miniature-winged males. The daughter which proved to be sterile was found on dissection to have only one undeveloped ovary. The other which was fertile produced 174 regular daughters, 198 regular sons, 1 exceptional daughter, and 5 exceptional sons. The

[6] *Genetics*, Vol. 5, No. 5, 1920.

exceptional daughter (the F_2 from the X-rayed female) was fertile in a second mating with an eosin-eyed miniature-winged male (the first mating was sterile) and produced one exceptional daughter (white-eyed and normal-winged). Of the five exceptional males (F_2 from the X-rayed female) two were proved to be fertile. The exceptional female (F_3 from the X-rayed female) proved fertile when mated with an eosin-eyed miniature-winged male and produced one exceptional daughter (F_4 of the X-rayed female). Since only one of the two exceptional females was fertile more data is required before it can be assumed that the exceptional females formed as a result of X-rays applied to the egg are fertile and produce further exceptions.

The experiments described confirm my earlier findings that X-rays may be made to affect the germ cells and show further that the effect produced on the first generation, so far as at present investigated, is identical with primary non-disjunction.

The writer wishes to express his indebtedness to the Research Laboratory of the General Electric Company for their continued interest in this work, to Dr. T. H. Morgan and Dr. C. B. Bridges for helpful criticism and suggestions and to Mr. O. J. Irish for technical assistance.

JAMES W. MAVOR

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THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

REPORT OF THE SECRETARY-TREASURER OF THE PACIFIC DIVISION FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1921

January 1, 1921—Cash balance		$ 847.30
Receipts:		
Received from the permanent secretary's office	$1,639.00	
Affiliated societies	125.00	
Dues and fees	520.00	
Finance committee, Berkeley meeting	98.21	
		$2,382.21
		$3,229.51
Expenditures:		
Dues remitted to permanent secretary's office	$ 293.00	
Supplies	6.58	
Salary 1921	825.00	
Salary 1920	75.00	
Office assistance	300.00	
Postage and express	41.00	
Telephone and telegraph	20.45	
Expense general	5.00	
Membership campaign	81.60	
Finance committee, Berkeley meeting	5.34	
Ukiah Observatory donation	50.00	
		$1,702.97
January 1, 1922—Cash balance		$1,526.54

BALANCE SHEET, DECEMBER 31, 1921

Assets

Equipment	$ 235.73
Cash on hand	1,526.54
	$1,762.27

Liabilities

Permanent secretary's office	$1,426.54
Investment	235.73
Sundry creditors	100.00
	$1,762.27

SUMMARY OF ANNUAL DISBURSEMENTS FOR THE YEAR 1921

Supplies	$ 6.58	
Salary	900.00	
Office assistance	300.00	
Postage and express	41.00	
Telephone and telegraph	20.45	
Expense general	5.00	
Membership campaign	81.60	
Ukiah Observatory donation	50.00	
		$1,404.63
These disbursemeents have been made from funds derived as follows:		
Finance committee, Berkeley meeting	$ 92.87	
Affiliated societies (assessments)	125.00	
Initiation fees	230.00	
Receipts from the permanent secretary's office	956.76	
		$1,404.63

COMPARATIVE STATEMENT OF RECEIPTS AND DISBURSEMENTS FOR THE YEARS 1920 AND 1921

	1920	1921
Received from the permanent secretary's office:		
Balance on account 1919	$ 750.00	
Account 1920 and 1921	1,014.00	
Account 1921-1922		$1,639.00
Received from affiliated societies	115.00	125.00
Received from new members, dues	109.00	290.00
Received from new members, initiation fees	163.00	230.00